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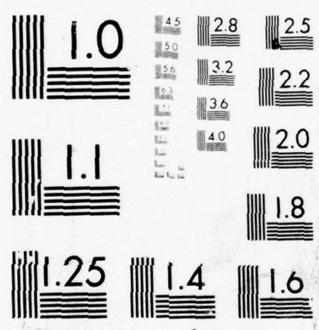

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Three levels of feedforward information and five levels of feedback information were administered during a 200 two-cue trial experiment to 150 subjects. The feedforward information consisted of instructions on correlative relationships and cue validities. The feedback information consisted of outcome feedback presented at different rates. Results indicated that: (a) subjects provided with a psychologically relevant MCPL setting with labeled cues can perform at a very high level of proficiency without feedforward or feedback information, (b) statistically naive subjects are unable to use feedforward information to improve their performance, (c) whether subject performance increases or decreases when provided with feedback information depends upon the performance index used (i.e., r_a and R_s decrease, while r_m increases), and (d) withdrawal of feedback generally has little effect upon subject performance.

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FEEDFORWARD AND FEEDBACK IN MULTIPLE
CUE PROBABILITY LEARNING--
FACILITATING OR DEBILITATING?

William H. Hendrix, Lt Col, USAF

AU-AFIT-LS-1-79

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FEEDFORWARD AND FEEDBACK IN MULTIPLE CUE PROBABILITY LEARNING--FACILITATING OR DEBILITATING?

A School of Systems and Logistics AU-AFIT-LS Technical Report

Air University

Air Force Institute of Technology

Wright-Patterson AFB, Ohio

By

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Lieutenant Colonel, USAF

July 1979

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Feedforward and Feedback in Multiple Cue Probability Learning--Facilitating or Debilitating?

Introduction

Multiple Cue Probability Learning (MCPL) research has typically employed trial-by-trial outcome feedback; the basic assumption being that subject performance will improve if the subject is provided with outcome feedback during the learning experiment. Recent evidence questions the validity of this assumption. For example, Hammond and Summers (1972) have noted that subject performance (specifically R_s) decreases when outcome feedback has been provided, as opposed to receiving no outcome feedback where no decrease was noted. They suggested that in learning tasks involving probabilistic relationships between cues and criterion, outcome feedback contains erroneous information. This erroneous information results in response inconsistency and, therefore, performance is affected adversely. Hammond, Summers, and Deane (1973), based on the above proposal, hypothesized that if outcome feedback is withheld, then subject response inconsistency would decrease and, in turn, performance should increase. They tested this hypothesis and found support for it in a research experiment in which 30 University of Colorado undergraduates served as subjects. Results indicated that outcome feedback was not only unnecessary for improving subject performance, but was detrimental for all three performance indices: r_a, R_s, and r_m. Support for this hypothesis has also been reported by Castellan (1974), Holzworth and Doherty (1974), and Swaine and Castellan (1974), who found that subject performance was adversely affected by providing subjects with feedback information. Some of the feedback provided was outcome feedback, but other types were also provided (e.g., utilization coefficients).

More recently, there has been some interest in the effects due to what Bjorkman (1972) has called feedforward information; that is, information about a task which is given to subjects prior to task accomplishment. For example; Dudycha, Dudycha, and Schmitt (1973); Newton (1965); Magnusson and Nystedt (1969); and Nystedt and Magnusson (1973) obtained results which indicated that subjects were able to improve their performance by feedforward information, such as ecological validity coefficients, and obtaining the sign of correlative relationships. Holt (1958), however, has obtained results which indicated that subject performance did not increase when subjects were given ecological cue-criterion validities.

The present investigation focused on these two areas of interest and involved examining the effects of feedforward and feedback information on subject performance in a psychologically meaningful setting. This study differs, therefore, in that these two factors are examined within the same experimental design--which has not been accomplished by previous studies. Brunswik's lens model (1952, 1956), as delineated in Dudycha and Naylor (1966), and Muchinsky and Dudycha (1974), served as the theoretical framework for the investigation. The lens model subject performance indices relevant to the present investigation include: (a) subject achievement (r_a), the correlation between the subject's response and the criterion values; (b) subject matching (r_m), the correlation between the subject's predicted responses and the predicted criterion values; (c) subject consistency (R_s), the correlation between the subject's responses and his predicted responses.

The major questions under investigation were: (a) Does subjects' performance differ under three levels of feedforward information?; (b) Does subjects' performance differ under five levels of feedback information?; and (c) Are there interaction effects between feedforward and feedback levels? In attempting to answer these questions, subjects' performance was investigated over blocks of trials where outcome feedback was given (i.e., blocks 1-6) and over the terminal performance blocks (i.e., blocks 7 and 8) where no feedback was given (see Table 1). A condition was therefore created where a series of feedback treatments were applied (in blocks 1-6) and the effect on performance subsequently measured after feedback withdrawal (i.e., blocks 7 and 8).

Method

Experimental Design

The experimental design and the levels of the independent variables are presented in Table 1. The first factor is the feedforward (FF) factor with three levels. As indicated earlier, feedforward information is any information which is given the subjects *prior* to the administration of the experimental trials, as opposed to feedback information which is given subjects *after* administration of one or more trials.

The first level (FF_1) served as the control group for this factor. Subjects received only standard instructions in which they were told they were to be presented with two test scores for a total of 200 college graduate school applicants. Their task, in turn, was to rate each applicant on a scale of 10 to 90 on his probability of succeeding in graduate school. The second level (FF_2) consisted of providing subjects with standard instructions plus an explanation of correlative relationships. Specifically, they were shown scatter plots and explanations were given of the correlative relationships of .00, .50, and 1.00. The third level (FF_3) consisted of providing subjects with the same instructions as for FF_2 plus giving subjects the actual ecological validities (i.e., .80 and .50).

The second factor, feedback information (FB), consisted of 5 levels, with the total number of feedback trials held constant at 75 for feedback conditions 2, 3, and 4. The first level, FB_1 (no feedback condition), served as the control group for the feedback factor. For this condition, the subjects were not given outcome feedback after they made their responses. The second level, FB_2 (random feedback condition), consisted of providing subjects with a total of 75 outcome feedback trials randomly presented over the first 150 trials. The third level, FB_3 (massed alternate block condition), consisted of providing subjects with trial-by-trial outcome feedback in every other block of 25 trials (i.e., blocks 2, 4, and 6), with a total of 75 feedback trials presented. The fourth level, FB_4 (massed random condition), consisted of providing subjects with trial-by-trial outcome feedback in block 1 (i.e., massed feedback) and then 50 trials of random outcome feedback during blocks 2 through 6 (trials 26-150). The last level, FB_5 (trial-by-trial outcome feedback condition), consisted of providing subjects with the traditional trial-by-trial outcome feedback during blocks 1 through 6.

The third factor, blocks of trials, consisted of a total of 200 trials divided into 8 blocks of 25 trials each for analysis of learning.

Subjects

Subjects were 150 students enrolled in the introductory psychology course at Purdue University. There were 10 subjects per condition for all conditions in the experiment. Participation in psychological experimentation was a course requirement; however, each student was permitted to select and participate in those experiments which were of interest to him.

Stimuli Generation

A total of 200 stimulus profiles (i.e., cue-criterion profiles) were generated in 8 blocks of 25 trials each by using the Ohio State Correlated Score Generation Method (Wherry, Naylor, Wherry and Fallis, 1965). Two cues were used; the first labeled "College Entrance Examination Score (CEES)," and the second labeled "Dominance Score (DS)." The criterion was labeled "Faculty Rating (FR)." Both the cues and the criterion had means of 50 and standard deviations of 10. System predictability was $R_e^2 = .89$, cue 1 and cue 2 were orthogonal with validities of .80 and .50 respectively. The

Table 1

Experimental Design

		Feedback						No Feedback	
		B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8
	FB_1								
	FB_2								
FF_1	FB_3								
	FB_4								
	FB_5								
	FB_1								
	FB_2								
FF_2	FB_3								
	FB_4								
	FB_5								
	FB_1								
	FB_2								
FF_3	FB_3								
	FB_4								
	FB_5								

sampling error for the empirical validities and the cue intercorrelation was within ±.05 of the theoretical values for each block of 25 trials.

Presentation Apparatus

The cues and criterion data were displayed on a projection screen, using an opaque projector fitted with a device developed especially for this type of experiment. In order to display the 200 cue-criterion profiles, a series of the 200 profiles were typed on a roll of teletype paper. Each series represented a particular feedback condition. For example, the FB_1 (no feedback) condition had no Faculty Rating criterion feedback values typed in, while FB_5 (trial-by-trial outcome feedback) had Faculty Rating criterion scores for each profile. By using a template which had the cue-criterion labels typed on it, the cues and their titles could be presented alone on the screen or with the Faculty Rating criterion feedback. The device permitted the profiles to be presented sequentially from trial 1 through trial 200.

Procedure

For each of the 15 experimental groups, instructions and response sheets were handed out. The experimenter read the instructions aloud to each group as the subjects silently read along. For each experimental group, the subjects were instructed to learn the strategy which was appropriate to their condition.

Each experimental session began with three practice trials, after which any questions associated with the experiment were answered. During the experiment proper, for a given trial the subjects were: (a) presented with a display of the two cues, (b) given time to make their predictions on a response sheet provided, and (c) presented the cues along with feedback of the actual criterion value (i.e., Faculty Rating Score) if the given trial was a feedback trial (see Table 1 for the feedback schedules). The next trial was then presented, each trial taking approximately 15 seconds to complete. Each session lasted approximately one hour and ten minutes.

Analysis

The subjects' 200 responses were divided into 8 blocks of 25 trials each for analysis. Regression equations were computed which represented the subjects' utilization of cues over blocks, the optimal environmental regression equations over blocks, the predicted subject response, and the predicted criterion values. Next, the dependent subject performance indices of: (a) subject achievement (r_a), (b) subject consistency (R_s), and (c) subject matching (r_m) were computed and transformed to Fisher Z values. These values were then used as the input data for analysis based on the design in Table 1. Three ANOVAs were computed, one for each of the dependent variables--r_a, R_s, and r_m. All factors were treated as fixed, except for subjects. For the main effects found to be significant, simple main effects analyses were performed. In turn, significant simple main effects were then analyzed by the Newman-Keuls Sequential Range Test in order to identify specifically which means in a given level of a factor were significantly different.

Results

Subject Achievement

The analysis of variance summary table for subject achievement (r_a) is provided in Table 2. The main effects for blocks of trials (B) and the feedback by blocks of trials (FB x B) interaction were found to be significant. Simple main effects analyses were performed for all levels of these two factors. They indicated that the different types of feedback (FB) were significantly different for only blocks one and two, while the blocks effect was significant for each type of feedback.

Examining subject achievement across blocks of trials for the five feedback conditions revealed that subject performance was highest for the two feedback conditions (i.e., FB_1 and FB_3 conditions) in which subjects received no feedback during block 1 (see Figure 1). In block 2, the FB_3 condition resulted in a significant decrease in performance ($p < .01$) when feedback was given subjects, while the FB_1 (no feedback) condition results indicated a slight, though not significant, increase in performance. The FB_4 (massed random) condition had trial-by-trial outcome feedback in block 1, but during block 2 had only random feedback (i.e., feedback information was decreased). The performance for subjects rapidly increased ($p < .01$) for the FB_4 (massed random) condition during block 2. In block 3, subject performance in the FB_3 (massed alternate block) and FB_5 (trial-by-trial

Table 2

Analysis of Variance Summary Table for Subject Performance

		r_a		R_s		r_m	
Source[a]	df	MS	F	MS	F	MS	F
Between Subjects	149	.312		1.587		1.770	
FF	2	.062	.192	.723	.546	2.442	1.461
FB	4	.196	.611	12.199	9.211***	6.577	3.933**
FF x FB	8	.287	.893	.926	.700	.844	.505
Error	135	.321		1.324		1.672	
Within Subjects	1050	.051		.144		.399	
B	7	.838	19.410***	1.611	13.733***	1.937	5.083***
FF x B	14	.056	1.295	.156	1.328	.434	1.138
FB x B	28	.164	3.805***	.580	4.945***	.606	1.590*
FF x FB x B	56	.034	.798	.198	1.687***	.400	1.051
Error	945	.043		.117		.381	
Total	1199	.084		.324		.570	

[a] FF = Feedforward, FB = Feedback, B = Blocks of Trials.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

outcome feedback) conditions significantly increased. During blocks 6 and 7, there was an apparent increase in performance (block 6) and then a decrease (in block 7). This variation, however, could be due to the variation in system predictability of the generated profiles which directly co-varied with the performance indices, as did the control group over blocks 6, 7, and 8. Therefore, it is suggested that this apparent effect is a statistical artifact.

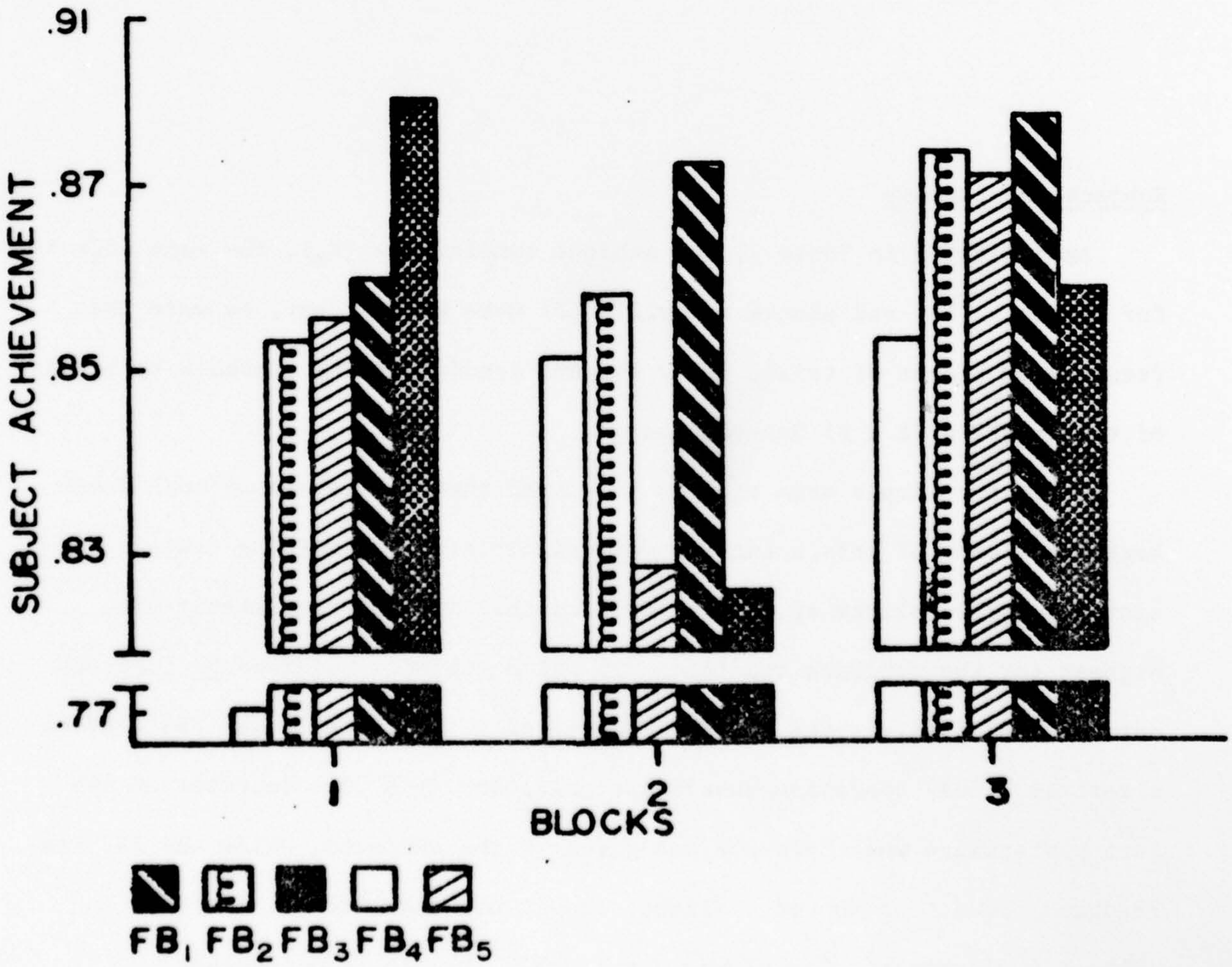
Subject Consistency

As indicated in Table 2, for subject consistency (R_s), the main effects for feedback (FB) and blocks of trials (B) were significant, as were the feedback by blocks of trials (FB x B), and feedforward by feedback by blocks of trials (FF x FB x B) interactions.

Tests for simple main effects indicated that all levels of both feedback and blocks of trials factors were significant. Examining subject consistency across blocks of trials revealed that subject consistency was highest for the feedback conditions in which subjects received no feedback during block 1 (i.e., FB_3 and FB_1 conditions). In block 2, the FB_3 (massed alternate block) condition showed a significant ($p < .01$) decrease in subject performance when feedback was given to the subjects, while the FB_1 (no feedback) condition showed a slight, though not significant, increase in subject performance. For blocks 2 through 8, the FB_1 (no feedback)

Figure Caption

Figure 1. Subject Achievement Over Blocks 1, 2, and 3.



condition was significantly ($p < .01$) higher than all other FB conditions, except in block 5 where there was no significant difference between the FB_1 (no feedback) and FB_3 (massed alternate block) conditions.

The FB_4 (massed random) condition in block 1 had a trial-by-trial outcome feedback; however, in block 2, this feedback was reduced (i.e., a random feedback schedule was started). This reduction in feedback was accompanied by a significant ($p < .01$) increase in subject performance in block 2.

Focusing on terminal performance (blocks 6, 7, and 8), under FF_2 and FF_3 conditions, there was a distinct and significant difference between the FB_1 and FB_5 conditions. Specifically, subject consistency tended to remain at a high performance level under FB_1 and to decrease under the FB_5 condition.

Subject Matching

The analysis of variance summary table for subject matching (r_m) in Table 2 reveals that main effects for feedback (FB), and blocks of trials (B) were significant, as was the feedback by blocks of trials (FB x B) interaction. Once again, interest was focused upon the significant interaction, and simple main effects analysis performed for each level of the two factors (i.e., FB and B). The test for simple main effects indicated that subject matching (r_m) was significantly different under different FB conditions at blocks 1, 2, 6, 7, and 8. In addition, across blocks of trials, the FB_3 (massed alternate block) and FB_5 (trial-by-trial outcome feedback) factorial levels were found to be significant.

Examining subject matching over blocks of trials revealed a performance pattern which was almost the reverse in block 1 of that found for r_a and R_s; that is, the no feedback conditions (FB_1 and FB_3) had the lowest performance values during block 1. The only significant difference, however, for block 1 was between the FB_4 (massed random) and FB_1 (no feedback) conditions ($p < .01$), where FB_4 (massed random) during block 1 was trial-by-trial outcome feedback, and FB_1 was no feedback to the subjects. In block 2, the matching index for the FB_3 (massed alternate block) condition decreased when feedback was provided the subjects (decrease was not significant). This trend was the same as obtained for the r_a and R_s dependent variables. Looking across blocks, generally the FB_1 (no feedback) condition resulted in poorer performance, although not always significantly so, when compared to the other FB conditions.

In addition, for FB_3 (massed alternate block) and FB_5 (trial-by-trial outcome feedback) treatment groups, there was a significant ($p < .05$) increase in subject matching performance from block 5 to block 6 (last FB block), followed by a significant decrease in block 7 (first discontinued feedback block). This increase, followed by a decrease in subject matching performance, was not accompanied by the same significant effect for the control condition (FB_1). It appears that for r_m this effect is not a statistical artifact, as was suggested to be the case for r_a.

Results Across Dependent Variables

Blocks of trials effect. One of the most apparent differences between the dependent variables r_a, R_s, and r_m was noted when the means associated with the blocks of trials (B) main effect were examined. There was a clear indication that subject performance is, in part, a function of the performance index used. The magnitude of subject performance was greatest for subject matching (range = .982-.992), followed by subject consistency (range = .935-.963), and lastly subject achievement (range = .846-.902). This relative order of the performance indices supports previous research employing cues with positive ecological validities, which has generally found the same order effect. For example, this order effect was found by Schmitt (1972, pp. 23, 33, & 44) for abstract cues, and by Muchinsky (1973, pp. 95-96) for meaningfully labeled and positive validity cues. Another aspect worth noting is that all three dependent variables have high performance indices from blocks 1 through 8 (range = .864-.992) in this realistically labeled task.

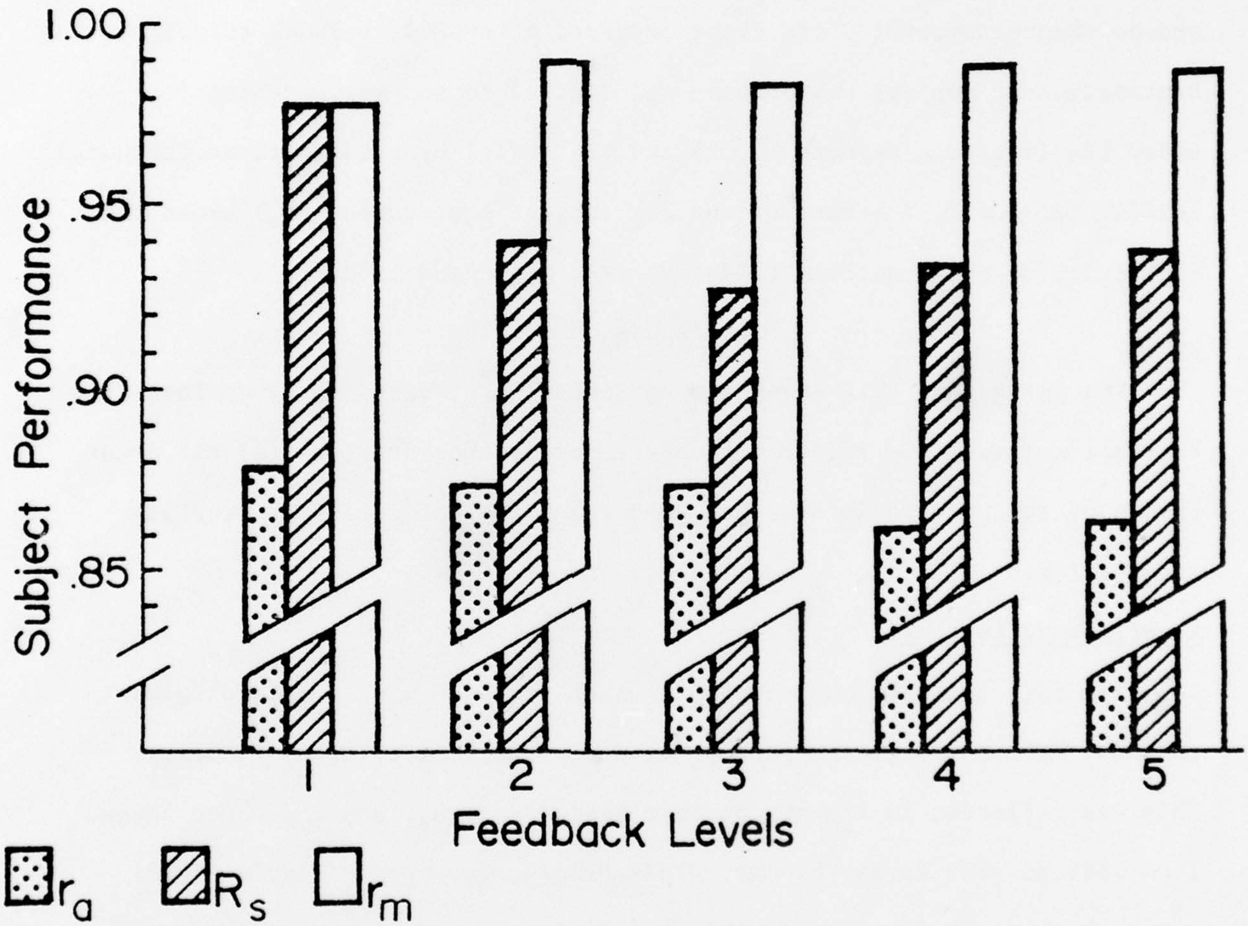
Feedback information effect. Figure 2 provides a plot of mean values associated with the feedback main effects. It reveals that subject performance across all blocks is greatest for R_s when no feedback (FB_1) is given subjects. On the other hand, subject performance is the poorest for r_m when no feedback (i.e., FB_1 treatment) is given subjects. This, of course, supports the previous detailed discussion of subject consistency and subject matching performance indices. In addition, if one considers that r_m is subject optimal performance with subject inconsistency removed, then it follows that r_m is a more important index of subject performance than are the indices r_a and R_s. If this line of reasoning is accepted, then it can be said that outcome feedback generally results in increasing subject performance.

Withdrawal of feedback effect. The discussion so far has revealed an apparent decrease in subject achievement (r_a) when feedback was discontinued, but it has been suggested that this was perhaps a statistical artifact. On the other hand, for subject matching (r_m), the same phenomenon occurred for FB_3 (massed alternate block) and FB_5 (trial-by-trial outcome feedback) treatment groups; but, for that case, it appeared not to be a statistical artifact. For subject consistency (R_s), there was no such significant phenomenon for any of the feedback groups. Therefore, upon looking for significant difference between blocks 6 and 7, and blocks 7 and 8, there appeared to be no significant increase or decrease in subject performance after feedback was withdrawn, except for r_m under FB_3 (massed alternate block) and FB_5 (trial-by-trial outcome feedback) conditions.

Another way of approaching this problem is to see if subject performance differed between block 6 (last feedback block) and block 8 (last discontinued feedback block). This approach was taken by examining the results obtained from the Newman-Keuls Sequential Range Test. For subject achievement, the only significant difference was for the FB_5 (trial-by-trial outcome feedback) treatment condition ($p < .01$), while subject consistency had no significant differences. On the other hand, subject matching had

Figure Caption

Figure 2. Feedback Main Effects for Subject Performance.



significant differences between blocks 6 and 8 for FB_3 ($p < .01$) and FB_5 ($p < .01$) conditions.

Taking the two approaches into account, it appears that subject performance was affected very little for the different feedback treatment groups when withdrawal of feedback occurred after 150 feedback trials. Degradation of subject performance was limited to subject matching (r_m) under FB_3 (massed alternate block) and FB_5 (trial-by-trial outcome feedback) conditions, and to a lesser extent for subject achievement (r_a) under the FB_5 (trial-by-trial outcome feedback) treatment conditions.

Discussion

The purpose of this study was to investigate, within a psychologically relevant setting, the effect on subject performance due to: (a) different levels of feedforward information, and (b) different levels of feedback information.

Experimental Setting

The data indicate that subjects, when provided with a psychologically relevant MCPL setting, can perform at a very high level of proficiency. This was reflected in the performance indices r_a, R_s, and r_m, which ranged from .864 to .992 across blocks. This finding supports Miller's (1973) research where he found that subjects' performance was worse in a mislabeled or no-labeled setting than in a setting with cues properly labeled. It also supports Muchinsky (1973) who investigated the effect of a suppressor variable on subject performance in a meaningfully labeled and abstractly labeled setting. Subject performance was found to be superior in a realistic setting with meaningfully labeled cues.

Feedforward Information

The lack of a significant main effect for feedforward information indicates that, generally, statistically naive subjects are unable to use this type of information adequately to improve their performance in an MCPL task. The one exception was for subject consistency (R_s) where a significant FF x FB x B interaction was obtained. For this case, feedforward information appeared to be affecting only terminal performance (blocks 7 and 8). When subjects were provided with only a set of standard instructions (feedforward 1), terminal performance resulted in no significant differences between types of feedback information given. However, when subjects were given either an explanation of correlative relationships (feedforward 2) or an explanation of correlative relationships plus the actual ecological validity relationships (feedforward 3), there resulted an increase in subject consistency for the no feedback condition (FB_1) and a decrease in subject consistency for the trial-by-trial outcome feedback condition (FB_5). Therefore, the data indicate that feedforward information affects subject consistency during terminal performance in a 200-trial MCPL task. For the FB_1 (no feedback) condition, performance drops off when only standard instructions are given, but increases when FF_2 or FF_3 information is given. On the other hand, trial-by-trial feedback (FB_5) results in decreased subject consistency when FF_2 or FF_3 information is given.

The above finding that statistically naive subjects generally are not able to use feedforward information adequately to improve performance supports Holt's (1958) study which indicated that subject performance did not increase when given the ecological cue-criterion validities. On the other hand, Newton (1965), Magnusson and Nystedt (1969), and Nystedt and Magnusson (1973) obtained data which indicated that subjects who were given ecological validity coefficients could use this information to improve their performance (r_a index). Dudycha, Dudycha, and Schmitt (1973) found that subjects given an explanation of positive, zero, and negative correlative relationships performed better than subjects without this type of information, but performed even better when given the actual ecological validity relationships--all of which were negative correlations.

First, Newton's (1965) study is highly suspect since the results associated with feedforward and feedback effects are confounded. On the other hand, the studies of Magnusson and Nystedt (1969); Nystedt and Magnusson (1973); and Dudycha, Dudycha, and Schmitt (1973) obtained clear evidence that subject performance increased when feedforward information was given. There is one area which is common to these studies; namely, that the subjects were statistically sophisticated (i.e., had some pre-experimental knowledge of statistical relationships). In the present study, the subjects were naive; that is, the subjects had no pre-experimental knowledge of correlative relationships. Therefore, subject statistical sophistication might account for the differences between these studies.

This is an area that requires further study. The area should be further investigated using statistically (not just mathematically) sophisticated subjects and statistically naive subjects in order to ascertain if statistical sophistication is a moderator variable in MCPL tasks.

Feedback Information

The data obtained from this study indicate that whether feedback information increases or decreases subject performance depends upon the performance index used. Generally, subject performance increases if feedback is given when the performance index used is subject matching (r_m). On the other hand, performance decreases with feedback when the indices of subject consistency (R_s) and subject achievement (r_a) are used.

Initial performance. In addition to this overall trend, there is an effect due to feedback during the early stages of an MCPL task (blocks 1 and 2) which generally parallels the trend described above. For subject achievement (r_a) and subject consistency (R_s), performance was the highest when no feedback was presented. If feedback was reduced after receiving feedback for 25 trials, performance increased; while if feedback was given after no feedback in block 1, performance decreased. On the other hand, for subject matching (r_m), performance was the poorest when no feedback was given.

Terminal performance. During terminal performance (blocks 7 and 8), there appeared to be an effect when using the performance indices r_m and R_s, but not for r_a. The terminal performance effect associated with subject consistency (R_s) was discussed previously relative to the FF x FB x B interaction. For subject matching (r_m) performance, there was a significant increase for groups receiving FB_3 (massed alternate block) and FB_5 (trial-by-trial outcome feedback) information during the last feedback block (block 6) and a significant decrease when feedback was discontinued in block 7. These two experimental groups received trial-by-trial outcome feedback during block 6.

The data suggest that for the performance index r_m, subjects receiving trial-by-trial outcome feedback performed as though they were sensitive to the experimental instructions, which indicated that block 6 was the last feedback block. The subjects increased their performance during block 6 to the highest magnitude obtained during the experiment, then decreased their performance when feedback was permanently discontinued in block 7.

This is another area in need of further research. Do subjects receiving trial-by-trial outcome feedback rely heavily upon it, and--knowing that it is to be permanently withdrawn--decrease their subject matching performance upon feedback withdrawal?

Feedback literature. There has been little research associated with the effect of different schedules of feedback on subject performance in MCPL tasks. Somewhat related to this area, however, are the studies of Castellan (1974); Hammond and Summers (1972); Hammond, Summers, and Deane (1973); Holzworth and Doherty (1974); and Swaine and Castellan (1974). Taken together, the above studies indicate that outcome feedback may be detrimental to learning complex probabilistic relationships such as those associated with MCPL tasks. This result is in general support of the findings of this research study for the performance indices r_a and R_s, but not for r_m. The detrimental effect was most clear for R_s, where there was a marked differential between the no outcome feedback condition and the remaining four feedback conditions. In addition, the most detrimental effect associated with the present research study was found during initial performance (blocks 1 & 2). Obviously, since so little research has been performed in this area, final opinion should be reserved until more evidence is available. Nevertheless, it appears at present that outcome feedback degrades performance for the indices r_a and R_s, with the greatest effect being during initial performance in blocks 1 and 2.

Conclusion. The data suggest: (a) that subjects provided with a psychologically relevant MCPL setting with labeled cues can perform at a very high level of proficiency without feedforward or feedback information, (b) that statistically naive subjects are unable to use feedforward information to improve their performance, (c) that whether subject performance increases or decreases when provided with feedback information depends upon the performance index used (i.e., r_a and R_s decrease, while r_m increases), and (d) that withdrawal of feedback generally has little effect upon subject performance.

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